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Bait Stations as a Means of Rodenticide Presentation to Control Columbian Ground Squirrels

by
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Abstract

Field trials conducted in Lewis and Clark County, Montana during the summer of 1982 tested three styles of bait stations for acceptance by Columbian Ground Squirrels (*Spermophilus columbianus*). Each style of bait station was used by the ground squirrels and was easily serviced and weather-tight. Two anticoagulant rodenticides, bromadiolone and diphacinone, were tested in the bait stations. Both compounds were efficacious on Columbian Ground Squirrels. Control was delayed or inhibited by survival of nursing young and repopulation of study plots by ground squirrels from adjacent areas.

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INTRODUCTION

Traditional methods for managing ground squirrels with acute toxic baits have involved the surface application of measured quantities near each active burrow entrance. Because this method exposes toxic bait to nontarget animals the use of bait stations has been suggested as an alternative method of bait presentation that might reduce risks of primary poisoning of certain nontarget animals. Anticoagulant rodenticides have been used successfully in bait stations for commensal rodent control. Bait stations also have been used successfully to present rodenticides to ground squirrels (Clark, 1978; Baker, 1980; Crosby, Pers. Comm.). Since no previous work on the effectiveness of bait stations in field rodent control has been done on Montana rodents this study was initiated.

Use of brand name products does not imply an endorsement by the Montana Department of Agriculture.

OBJECTIVES:

1) To test the acceptance of bait stations by Columbian Ground Squirrels (*Sperophilus columbianus*).

2) To test the serviceability and weather-tightness of various styles of bait stations.

3) To test the efficacy of 2 anticoagulant rodenticides, bromadiolone and diphacinone, on Columbian Ground Squirrels.

METHODS AND MATERIALS

Study Areas

Three study areas were selected near Helena, Montana in May, 1982 on farmlands colonized by Columbian Ground Squirrels. Site 1 was an irrigation canal bank and a nonirrigated field edge which bordered a flood irrigated alfalfa field. The canal bank was vegetated with grasses and various weedy plants including thistles, knapweed and mullein. The alfalfa field edge had sparse stands of alfalfa and large patches without alfalfa which were vegetated primarily with tansy mustard. The site had a dense population of Columbian Ground Squirrels along the canal bank extending into the alfalfa field to the first irrigation lateral (Figure 1). The site was bordered on the south by the irrigation canal, on the north by irrigated alfalfa and the east and west by noncrop areas consisting of sparsely vegetated native dryland grass and sagebrush. Squirrels occurred south of the canal and east of the plot. The canal provided a barrier to squirrel movement onto the study plot from the south. Site 1 covered approximately 2 hectares (5 acres) and was treated with diphacinone in Eco-bait stations.

Study site 2 was a nonirrigated pasture approximately 1.4 hectares (3.4 acres) in size (Figure 2). Vegetation consisted of alfalfa and grasses with small patches of Canada thistle and mustard species. Squirrels were densely populated on the west side of the plot on sloping ground. Two other concentrations occurred on 2 east-west ridges running across the plot. Other burrows were scattered throughout the site. The plot was bordered on the west by a 4 lane interstate highway and a 2 lane highway on the east. The north and south sides were bordered by houses. The area to the east of the site across the 2 lane highway was lightly populated with squirrels. Site 2 was treated with diphacinone in metal ammunition box bait stations and PVC pipe bait stations. Two to five horses were present on the pasture during the time of the study.

Study site 3 was a noncrop, dryland, grass-sagebrush site of approximately 1.6 hectares (4 acres) bordering irrigated alfalfa (Figure 3). The east, south and west sides were bordered by large fallow areas. Site 3 was treated with bromadiolone in metal ammunition box stations.

Two sites were established as control plots. Control plot 1 was a dry, noncrop site of grasses, sagebrush and musk thistle. It was densely populated with squirrels and was used as a control plot for burrow closures conducted on study sites 1 and 3. Control plot 2 was an unimproved pasture consisting of dryland grasses and forbs. It was lightly populated with squirrels and used as a control plot for visual counts conducted on study site 2.

Census Methods

Efficacy of the toxicants was measured by comparing the number of active burrows before and after treatment. Burrow openings were flagged and closed with soil 4 days prior to treatment of the study site. Open burrows were counted 2 days after closure. Burrows opened were considered active and that number was used as the pretreatment count. Unopened burrows were omitted from further censusing. Posttreatment burrow counts were conducted periodically in the same manner throughout the study period using the previously marked pretreatment burrows. Burrow closures were used on sites 1 and 3. Burrow closures were not used on site 2 because of the tendency of livestock to disturb burrow markers. Percent reduction in active burrows was calculated as follows (Henderson and Tilton, 1955):

$$\text{Percent Reduction in active burrows} = 1 - \frac{\text{Holes reopened posttreatment (treated plot)} \times \text{Holes reopened pretreatment (control plot)}}{\text{Holes reopened pretreatment (treated plot)} \times \text{Holes reopened posttreatment (control plot)}} \times 100$$

Figure 1. Study site 1: Irrigation canal bank and alfalfa field edge. Diphacinone bait.

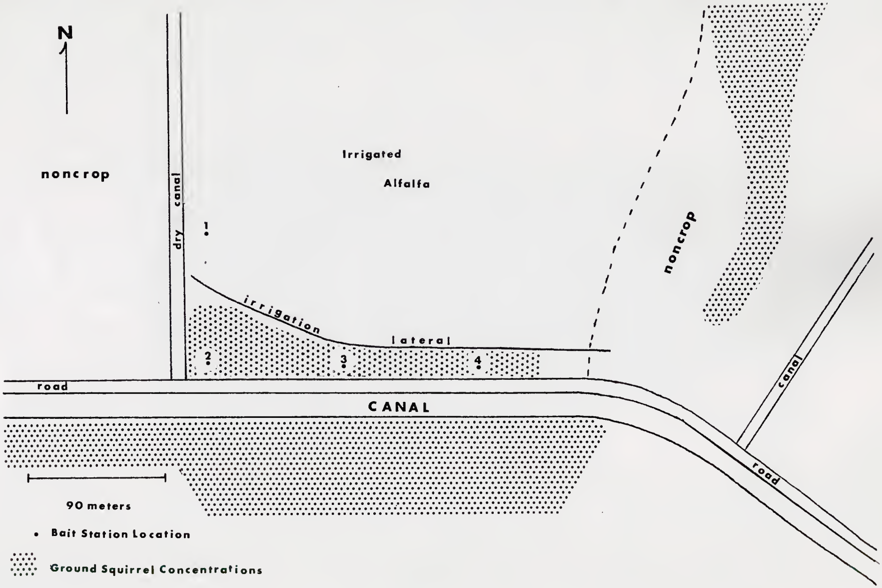


Figure 2. Study site 2: Improved pasture, Diphacinone bait.

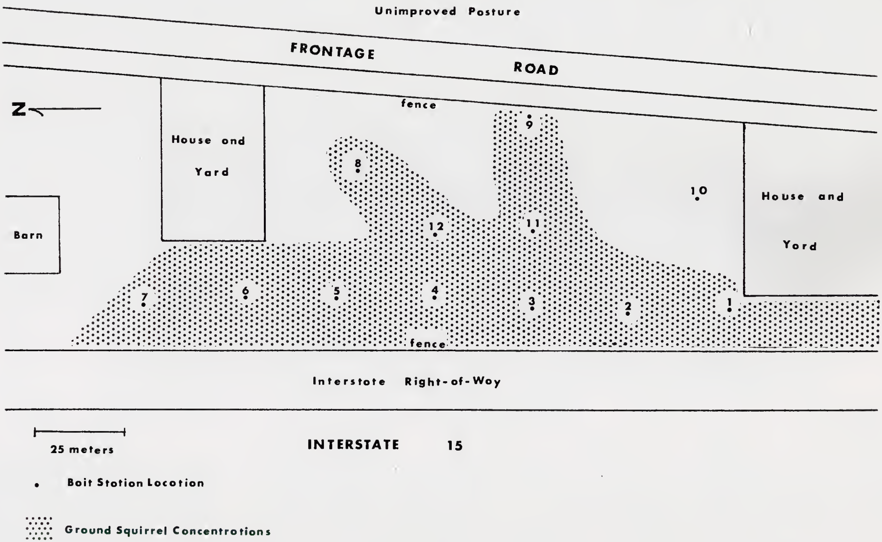
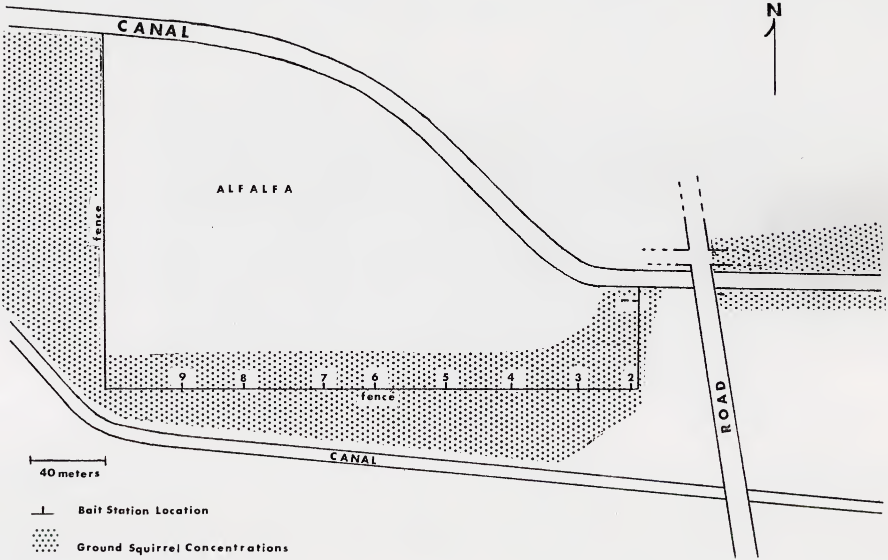


Figure 3. Study site 3: Noncrop, dryland, grass-sagebrush site bordering an alfalfa field, Bromadiolone bait.



A second method of determining efficacy involved visual counts of ground squirrels on the plots to generate activity indices. Three counts were made of squirrels on the study site during morning foraging periods at 5 minute intervals using binoculars. Pretreatment counts were conducted on 3 consecutive days before treatment. Posttreatment counts were conducted periodically until vegetation growth made counts no longer possible. Rate of vegetation growth prevented the use of visual counts on sites 1 and 3. Visual counts were effective on site 2 for 5 to 6 weeks because grazing by horses kept vegetation low. Percent reduction in activity was computed as follows:

$$\text{Percent reduction in activity} = 1 - \frac{\begin{matrix}\text{Squirrels counted}\\ \text{posttreatment}\\ \text{(treated plot)}\end{matrix} \times \begin{matrix}\text{Squirrels counted}\\ \text{pretreatment}\\ \text{(control plot)}\end{matrix}}{\begin{matrix}\text{Squirrels counted}\\ \text{pretreatment}\\ \text{(treated plot)}\end{matrix} \times \begin{matrix}\text{Squirrels counted}\\ \text{posttreatment}\\ \text{(control plot)}\end{matrix}} \times 100$$

Squirrel activity was also measured by the amount of bait consumed during the course of the study. Squirrel activity measured by bait consumption was used on all 3 study sites.

Bait Stations

Design - Three styles of bait stations were used in this study: Eco-bait stations, ammo-box bait stations and PVC pipe bait stations.

1) The Eco-bait station (Patent pending) is a commercially made device developed for delivering strychnine grain baits to Richardson ground squirrels (*Spermophilus richardsoni*). The station, made of heavy gauge metal, consists of a circular top placed over a bait pan and secured to the ground by a stake through the center. The station is open to access by squirrels from all sides.

2) The ammo-box bait stations were constructed from metal U.S. Army surplus ammunition containers (Figure 4). Two holes were cut in a corner of the large side of the box directly opposite each other. A wooden baffle was placed across the bottom of the box separating the inside into a feeding area and a bait trough. The baffle was placed approximately 13 cm (5 in.) from the front of the box. Three 3 mm (1/8 in.) drainage holes were drilled in the floor of the feeding area. The bait station was secured to the ground by a 25 cm (10 in.) nail spike driven through a hole in the bottom of the box.

3) The PVC pipe bait stations were made in a configuration that can be described as an off-set "T" (Figure 5). The material

use in construction was 3 inch diameter PVC pipe. The base pipe is open allowing squirrels to see and pass through the base pipe.

Bait Station Placement - On site 1 bait stations were placed along the canal bank without regard to density of squirrel burrows. Stations were placed approximately 90 meters (300 feet) apart. On sites 2 and 3 stations were generally placed in areas of greatest burrow density. Distance between stations varied from a minimum of 18 meters (59 feet) to a maximum of 55 meters (180 feet). Density of stations at sites 1, 2 and 3 were 2/hectare (0.8/acre), 8.6/hectare (3.5/acre) and 5.6/hectare (2.25/acre) respectively.

Station Operation - After initial placement on the study sites each station was prebaited with untreated whole oats. Each station was checked daily to determine the onset of use and rate of oat consumption. When at least one half of the stations on a study plot were showing 50-100% consumption of the prebait within a 2-3 day period the prebait was replaced with toxic bait in all stations.

Dates of prebait placement on sites 1, 2 and 3 were 5/4, 5/17 and 5/13, respectively. Dates of toxic bait placement for sites 1, 2 and 3 were 5/12, 5/25 and 5/25, respectively.

During the first half of the study, plots and stations were checked and maintained daily. During the later stages of the study when station usage declined maintenance sometimes occurred at 4-5 day intervals.

The amount of bait placed and the date placed was recorded for each station. The amount of bait consumed from each station was estimated and recorded at each visit. Bait consumed was summarized in 7 day periods beginning on the date the toxic bait was placed in the bait stations.

Bait in any station that became excessively wet or moldy from wind driven rain was removed and replaced with fresh bait.

Toxicants

Two anticoagulant baits were used:

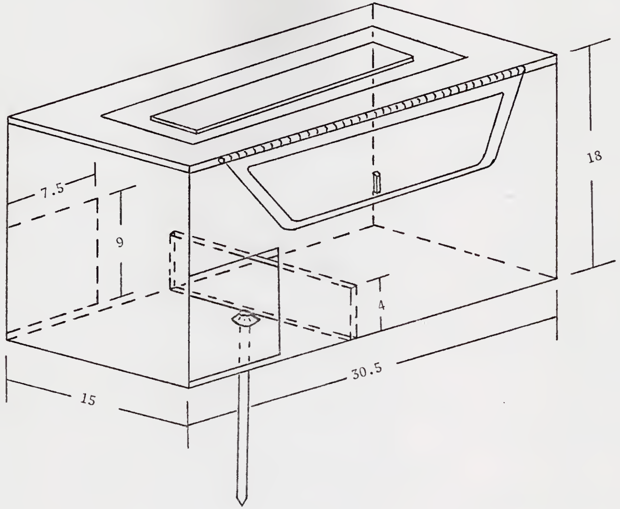
1) 0.005 % diphacinone in 0.5 inch cereal based pellets dyed green.*
2. 0.005% bromadiolone on whole hulled oats dyed red.**

* Velsicol Chemical Company, Trade Name Ramik Green, EPA Reg. No. 876-185-AA.

** Lipha Chemical Company, (federally registered for commensal rodents, Trade Name Maki, not presently registered for field rodents).

Figure 4. Ammunition box bait station. A. Oblique view. B. Side view. (Dimensions in centimeters.)

A.



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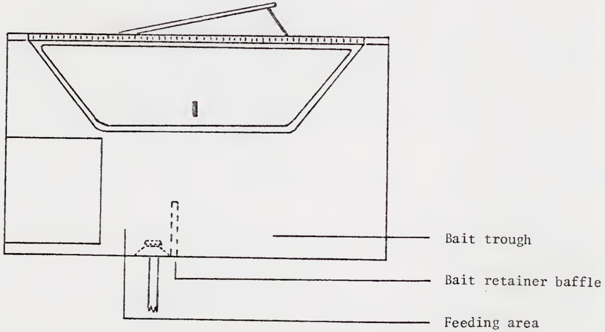
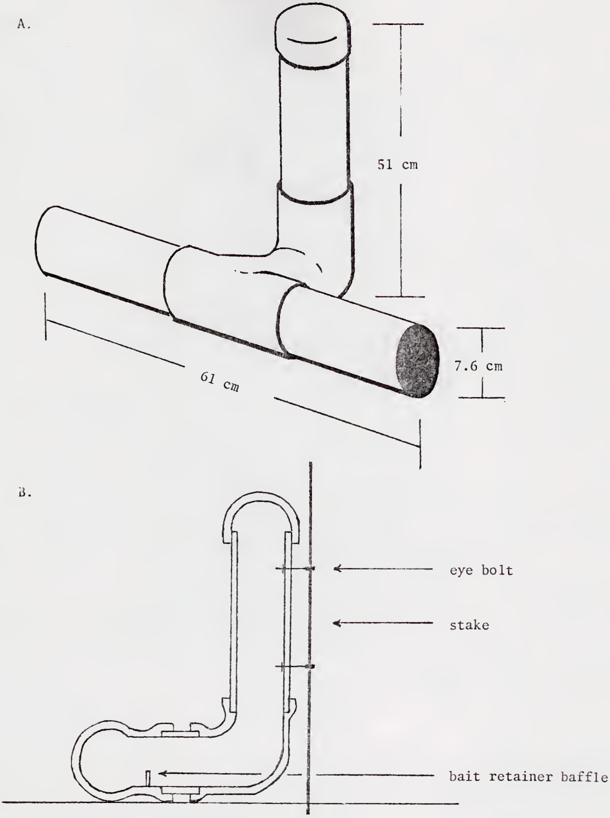


Figure 5. PVC pipe bait station (Designed by S. Baril, Montana Department of Agriculture) A. External view. B. Cross sectional view.

A.

B.



Target and Nontarget Searches

Searches for target and nontarget carcasses were conducted routinely during regular visits to the study sites. All carcasses found were collected and grossly necropsied for signs of hemorrhages. Notes were made on the presence of nontarget animals occurring on or near the study sites. Any feeding on squirrel carcasses by nontarget animals was recorded.

RESULTS

Bait Station Acceptance

Each style of bait station was used by the ground squirrels. Very little difference in the use of the stations by the squirrels were noted. Each style of station appeared to allow adequate access to the bait by the squirrels. The top of the Eco-bait stations and ammo-box bait stations were occasionally sat on by the squirrels.

Some stations were investigated after the first day of placement. The number of stations visited and amount of bait consumption increased gradually during the first week. Significant use of the bait stations occurred after about 1 week when at least one half were receiving at least 50 percent consumption of the prebait. One station on site 3 was not investigated until the tenth day after placement even though it was situated in an area with a high number of active burrows.

When the prebait was replaced by toxic bait, consumption decreased initially on site 2 (diphacinone) and site 3 (bromadiolone). Consumption increased gradually to prebait levels in 3 to 5 days after initial placement. At site 2 some of the ammo-box stations had the Diphacinone pellets dug out of the bait trough on to the feeding area for the first 1 to 3 days with little bait consumption. On site 1 (diphacinone) consumption did not decrease when toxic bait was placed.

Squirrels using the Eco-bait stations and the PVC pipe stations containing diphacinone bait usually consumed pellets singly while sitting alongside the station. Squirrels using the ammo-box stations containing diphacinone pellets consumed the bait while either sitting in the station or alongside it. Squirrels occasionally carried a pellet some distance away from a station before it was consumed. Consumption of bromadiolone on hulled oats occurred almost exclusively inside the ammo-box stations.

Bait Station Design

The Eco-bait station was easily and efficiently maintained. Bait in the station never became wet during the duration of the study despite several severe and prolonged rain storms.

The station was designed for use with strychnine grain baits. Because of the rapid action of strychnine and the small amount

required to be lethal a large bait container was not required. Because of the slow action of diphacinone squirrels fed on the bait for an extended period and consumed large quantities of bait. When the stations were receiving high usage by the squirrels the diphacinone bait was often completely consumed in 24 hours requiring daily replacement of bait. The Eco-bait station held approximately 1 pound of bait.

Surplus ammunition boxes were widely available and inexpensive. Holes were easily and quickly cut and drilled with simple power tools. Some stations began rusting during the course of the study so surface treatment may be desirable. Bait remained dry in light to moderate rain. Bait in some stations became water soaked from wind driven rain. This seemed to occur when the drainage holes were plugged by the box being tightly staked to the ground. The single baffle design allowed 2-3 pounds of bait to be placed in the boxes. By adding an additional baffle 4-6 pounds of bait could be contained in the ammo-box station.

Plastic PVC pipe and fittings are also widely available but cost of materials was greater than ammo-box stations. Longevity of the station should be nearly indefinite. Pipe can be cut with a hand saw and assembled by friction fit. Leaving the parts uncemmented permits dismantling the stations for storage and cleaning. Uncemmented joints may permit stations to come apart under disturbance by domestic or wild animals exposing the toxic bait. Two types of end caps were used to cover the top of the vertical pipe piece. A 1 piece slip-over end cap allowed no water to enter the station. A threaded end plug was unsatisfactory because water seeped through the threads on to the bait. The station had a capacity of 2 to 3 pounds of bait. Capacity could be increased to 4 to 6 pounds by increasing the diameter of the vertical pipe to 4 inches. Increasing the height of the vertical pipe would probably make the station less stable and increase the chance of the station being upset by livestock present.

Toxicant Efficacy

Both bromadiolone and diphacinone baits gave control of Columbian Ground Squirrels. The degree and rate of control varied on each plot as well as between each plot. Results of visual counts, burrow closures and bait consumption records are shown on Figures 6, 7 and 8, Tables 1 and 2 and Appendixes 1 and 2.

Target and Nontarget Observations

Twenty-two squirrel carcasses were found on the 3 study sites Sites 1, 2 and 3 had 3, 10 and 9 carcasses, respectively (Appendix 3). A few squirrels were observed that apparently showed effects of the anticoagulant. They moved slowly and were poorly coordinated. These squirrels were captured by hand, inspected for external bleeding and hematomas and released down a burrow.

Figure 6. Bait consumption by Columbian Ground Squirrels.

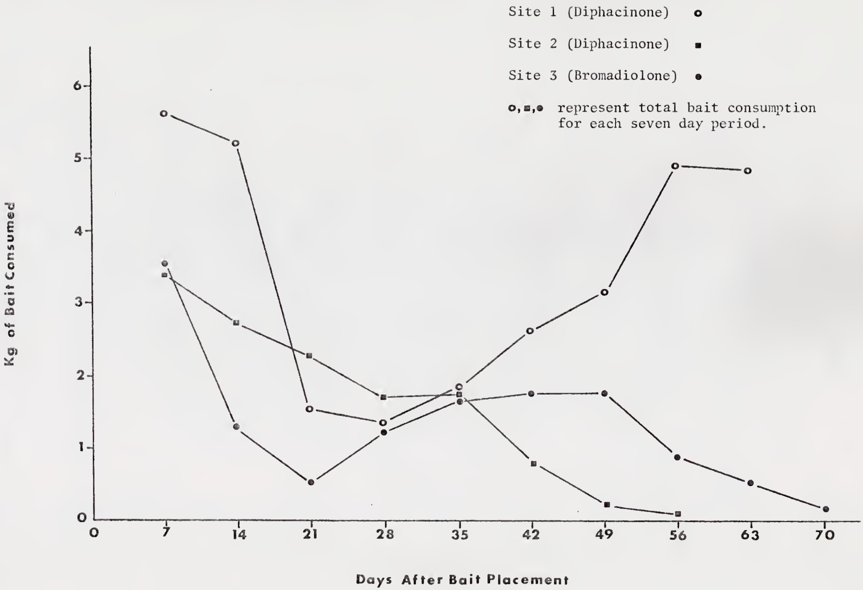


Figure 7. Percent reduction in ground squirrel activity based on reduction in active burrows.

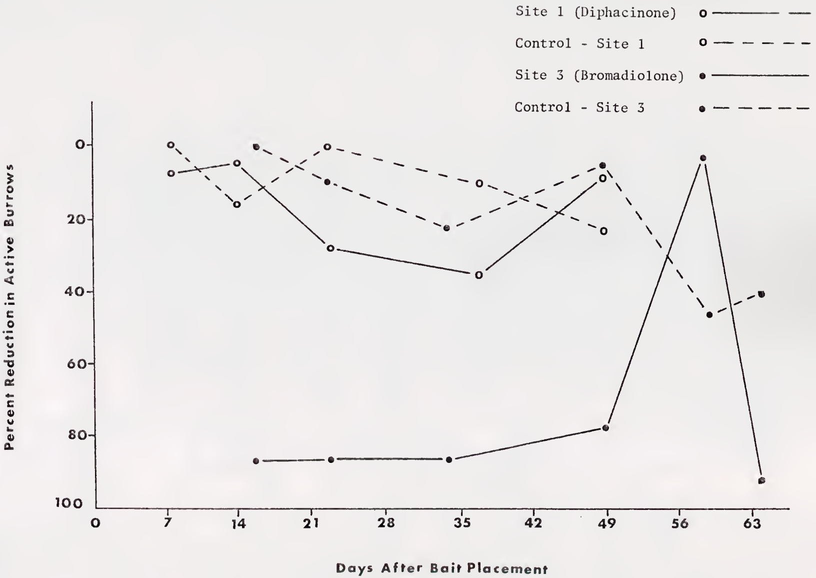


Figure 8. Percent reduction in ground squirrel activity based on visual counts. (▪ represents the average of visual counts for each 7 day period.)

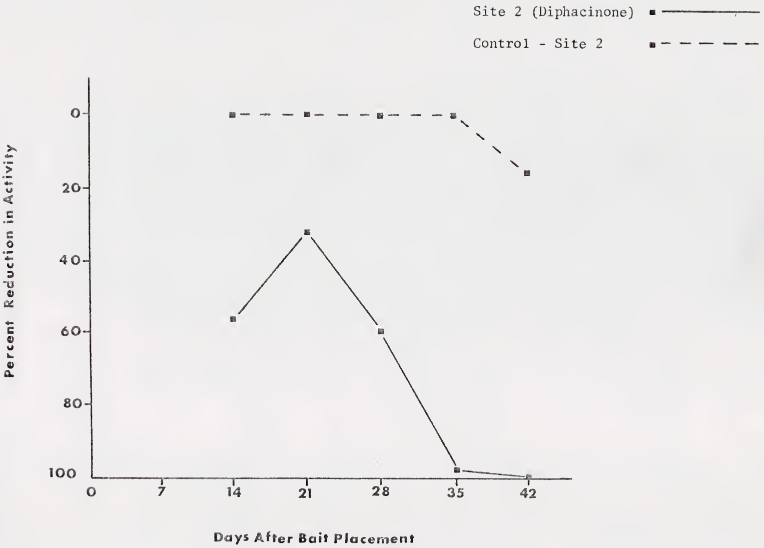


Table 1. Amount of Bait Consumed by Columbian Ground Squirrels

	Grams		
Week	Site 1 (Diphacinone)	Site 2 (Diphacinone)	Site 3 (Bromadiolone)
1	5,599	3,402	3,570
2	5,199	2,722	1,250
3	1,553	2,268	536
4	1,333	1,701	1,250
5	1,866	1,701	1,785
6	2,599	794	1,606
7	3,133	227	1,606
8	4,932	113	893
9	4,865	--	536
10	--	--	178
TOTAL	31,059	12,928	13,210

Table 2. Efficacy Determinations on Sites One, Two and Three Based on Visual Counts and Burrow Closures.

SITE TWO - (Diphacinone)

Percent Reduction in Activity Based on Visual Counts

Days After Bait Placement (5/25)	Treatment Plot	Control Plot
14 (6/08)	55.3%	0
21 (6/15)	32.7%	0
28 (6/22)	59.6%	0
35 (6/29)	98.2%	0
42 (7/06)	100.0%	15.4%

SITE ONE - (Diphacinone)

Percent Reduction in Active Burrows

Days After Bait Placement (5/12)	Treatment Plot	Control Plot
8 (5/20)	7.2%	0
14 (5/26)	4.2%	16.0%
24 (6/05)	28.8%	0
37 (6/18)	34.8%	9.5%
49 (6/30)	8.4%	22.2%

SITE THREE - (Bromadiolone)

Percent Reduction in Active Burrows

Days After Bait Placement 5/25)	Treatment Plot	Control Plot
16 (6/10)	86.4%	0
24 (6/18)	85.8%	9.5%
36 (6/30)	85.4%	22.2%
49 (7/13)	77.0%	5.0%
59 (7/23)	2.7%	46.0%
64 (7/28)	91.6%	40.0%

Only 1 animal believed to be a nontarget death, a White-footed Deer Mouse (Peromyscus maniculatus), was found near a station on site 3. One other Peromyscus believed to be affected by anticoagulant poisoning was also seen on site 3. Bait stations on all plots showed evidence of use by deer mice or voles (Microtus spp.) by the presence of droppings and feeding disturbance or tooth marks too delicate to be ground squirrels.

Site 1 and site 2 had no on site nesting birds and received little feeding use by birds. Black-billed Magpies (Pica pica) were observed feeding on squirrel carcasses on both plots. A single sighting of a Red-tailed Hawk (Buteo jamacicensis) on a squirrel carcass was made on site 1.

Habitat at site 3 provided for several on site nesting birds (Appendix 4). No direct observation of magpies feeding on carcasses was observed. One carcass was found with heart and lungs removed. One sighting of a Marsh Hawk (Circus cyaneus) feeding on a carcass was made.

Spillage of bait from the station by the squirrels was rare. A few diphacinone pellets were dug out of the ammo-box stations when the squirrels were first exposed to the bait. Partially consumed pellets were occasionally noted next to the stations during the course of the study. Only an occasional hulled oat of the bromadiolone bait was found outside the stations. The squirrels apparently fed on the bromadiolone bait almost exclusively within the ammo-box stations.

DISCUSSION

Clark (1978) investigated the use of bait stations on California Ground Squirrels (Spermophilus beecheyi) and stated that bait station design was limited only by one's imagination. Different designs using pipes, boxes, tires and propped up boards were used with success. Observations in this study indicated that station design had little influence on use by the squirrels. Probably the most important design criteria were adequate access and the presence of a desirable food source.

Several factors likely delayed or inhibited control on the study sites during the study period. Since juveniles stay close to their natal burrow after emergence, 1 to 2 weeks may have passed before they began using the stations. Juvenile and yearling dispersal probably began in late June to early July (Boag and Murie, 1981) and probably provided the major source of repopulation pressure to the study sites. Socially dominant squirrels may prevent or reduce the opportunities for subordinate squirrels to feed in stations (Murie and Harris, 1978; Festa-Bianchet and Boag, 1982) until the death of the dominant individuals, lengthening the time for control.

Movement of squirrels onto study sites 1 and 3 during the study was a major factor affecting study results. Evidence for repopulation was the increase in bait consumption on these plots

which corresponded to a decrease in efficacy indices. On site 1 squirrels east of the plot were likely the primary source of recruitment onto the study site (Figure 1). The area east of the 2 lane highway was probably a source of some squirrel movement onto study site 2 (Figure 2). Sources of repopulation of site 3 were from the canal bank on the east and a large noncrop area on the west edge of the alfalfa field (Figure 3). Repopulation of the study sites began in the second and third weeks of treatment after much of the original population was killed.

The low density and capacity of stations on site 1 probably could not handle existing population and the influx of new squirrels. This resulted in a substantial increase in bait consumption and active burrows (Figure 6 and 7). Stations were frequently found empty after a day of use indicating squirrel demand was greater than available bait supply.

Site 2 had the least potential for squirrel movement onto the site and repopulation was probably small. The peak on Figure 8 at 21 days was the result of recently emerged juveniles. The disparity between 100 percent control by visual counts at 42 days (Figure 8) and some feeding activity after 42 days (Figure 6) was the result of high vegetation growth preventing sight of the remaining squirrels.

The increase in bait consumption and relatively consistent number of active burrows on site 3 was the result of squirrel movement onto the plot. The increase in active burrows on plot 3 on day 59 of operation was the result of a substantial decrease in active burrows on the control plot and a corresponding increase in active burrows on the treatment plot (Figure 7, Appendix 1). Field observation indicated an increase in active burrows did occur but not to the extent calculated. A 50% reduction in active burrows is probably more accurate. The 92% reduction in active burrows on day 64 of operation indicates there was little repopulation of the plot in previous days and the existing squirrel population on the plot was nearly eliminated.

Estivation toward the end of the study may have influenced results beginning the end of July. The decrease in active burrows on the control plot was probably reflecting this (Table 2, Appendix 1).

The bait stations tested appear to offer protection to some nontarget animals from primary bait consumption. The entrance size restricts all but smaller animals from entering the stations. Some animals small enough to enter the stations are probably prevented from doing so by behavioral feeding patterns (i.e., most birds). Observations indicate small mammals did feed in the stations and their populations may be affected. Although small amounts of toxic bait were noted outside some stations the nontarget hazard would seem small. Providing stations are well secured to the ground they seem safe to use in areas where livestock are present.

Based on observations made during this study certain questions arise on which further study would be useful:

1) What are the economics of bait stations using anticoagulant baits related to size of area, value of area or crop, cost of bait and station maintenance?

2) What is the optimum spacing of bait stations to obtain control of ground squirrel populations?

3) Can bait stations be effective in preventing or reducing agricultural crop losses to ground squirrels when placed on crop border areas?

4) Can acute baits be effective in controlling squirrel populations when placed in bait stations?

CONCLUSIONS

Bait stations can be an effective means of bait presentation to control Columbian Ground Squirrels. Based on present observations their best application may be on small acreage crops and pastures and high value areas such as parks, golf courses, and cemeteries. Results will be most effective when used on small, relatively isolated squirrel populations where potential for repopulation from other areas is minimal. Bait stations may be applicable to larger acreages. Size of area controlled may be limited by economic considerations such as cost of bait, bait stations and bait station maintenance. Survival of nursing young may be avoided by starting station operation earlier in the ground squirrels breeding cycle. Under the conditions of this study stations placed 18 to 55 meters apart (sites 2 and 3) provided control of ground squirrels. Stations placed 90 meters apart (site 1) did not control ground squirrels.

Although control of ground squirrel was delayed by squirrel movement onto the study plots and survival of nursing young, bromadiolone and diphacinone baits placed in bait stations were efficacious in controlling Columbian Ground Squirrels. Based on general field observation bromadiolone and diphacinone probably would have gave 90-100% control in 4-6 weeks after initial bait placement had repopulation and survival of nursing young not occurred.

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Appendix 1. Burrow Count Data.

SITE ONE - (Diphacinone)

Active Burrows Pretreatment

Date	Treatment Plot	Control Plot
5/11	139	63

Active Burrows Posttreatment

Date	Treatment Plot	Control Plot
5/20	129	63
5/26	112	53
6/05	99	63
6/18	82	57
6/30	99	49

SITE THREE - (Bromadiolone)

Active Burrows Pretreatment

Date	Treatment Plot	Control Plot
5/18	132	63

Active Burrows Posttreatment

Date	Treatment Plot	Control Plot
6/10	18	63
6/18	17	57
6/30	15	49
7/13	29	60
7/23	62*	34
7/28	6*	38

* Hailstorm destroyed 10 flags marking active burrow reducing the number of marked active burrows marked to 118.

Appendix 2. Visual Count Data.

SITE TWO - (Diphacinone)

Active Burrows Pretreatment

Date		Treatment Plot	Control Plot
5/18		16	6
5/20		20	7
5/21		15	7
5/25		18	6
	Average	17.25	6.5

Active Burrows Posttreatment

Date		Treatment Plot	Control Plot
week 1 - cool, rainy weather prevented visual counts			
week 2 -			
6/03		10	7
6/07		8	6
6/08		7	7
	Average	8.3	
week 3 -			
6/10		12	7
6/15		13	9
	Average	12.5	
week 4 -			
6/18		9	4
6/21		6	9
	Average	7.5	
week 5 -			
6/24		0	7
6/25		1	7
6/28		0	8
	Average	0.33	
week 6 -			
6/30		0	6
7/01		0	5
	Average	0	

Average on control plot for all posttreatment counts = 7.

Appendix 3. Carcass Count Data.

Target

SITE ONE - (Diphacinone)

5/20	1 dead male: Red-tail Hawk on carcass when found
5/22	1 dead female
5/30	1 dead sex unknown: Carcass fed on, probably by magpie(s); heart, lungs and liver gone; intestinal tract removed and discarded
6/03	observed 1 sick female, caught by hand, hematoma on abdomen, blood around nose and mouth

SITE TWO - (Diphacinone)

6/04	4 dead (2 male, 2 female) one fed on by magpies, heart and lungs removed; observed 1 sick female, caught by hand, no external bleeding or hematomas noted
6/10	2 dead (one male, one female)
6/14	1 dead sex unknown: Carcass fed on by magpie(s); heart, lungs and liver gone; intestinal tract removed and discarded
6/18	3 dead (2 male, 1 female)

SITE THREE - (Bromadiolone)

5/30	1 sick, caught by hand, no external bleeding or hematoma 1 dead female
6/01	3 dead (2 female, 1 sex unknown): One carcass fed on by Marsh Hawk, portion of hindquarters consumed, intestinal tract removed and discarded
6/06	1 dead male
6/08	2 dead male
6/09	1 dead female, hematoma on lower abdomen
6/14	1 sick female, caught by hand, no external bleeding or hematomas
6/30	1 sick male, caught by hand, blood from left eye which apparently prevented sight, no other signs of bleeding or hematoma
7/13	1 dead sex unknown: Carcass fed on; heart and lungs removed; rest of carcass intact
7/16	1 sick male, caught by hand, no external bleeding, extensive hematoma on ventral surface of body

Nontarget

SITE ONE -

none observed

SITE TWO -

none observed

SITE THREE -

6/14	1 white-footed deer mouse, found six inches from station #1 no external bleeding or hematoma noted
6/25	1 white-footed deer mouse perhaps sick (slow moving and observed at midmorning) near station #6.

Appendix 4. Birds Nesting or Frequent Transients on Study Site Three

Nesters

* * Mallard Duck
* Red-tailed Hawk (nested ¼ mile from plot, fledged two young)
* * Gray Partridge
* Barn Swallow
* Cliff Swallow
* * Western Meadowlark
* * Brewer's Blackbird
* * Vesper Sparrow
* Clay-colored Sparrow

Transients

* * Shoveler
* * Blue-wing Teal
* * Cinnamon Teal
* * Killdeer
* Ring-billed Gull
* Franklin's Gull
* * Mourning Dove
* Black-billed Magpie

* A severe hailstorm occurred June 28, 1982. These species were killed, had nests destroyed or were absent or present in fewer numbers after the storm.